CLAIMS

1. A method for detecting the occurrence of surge or incipient surge in a centrifugal compressor, the compressor having an inlet passage, an inlet passage wall and an impeller, the method comprising the steps of:

operating the centrifugal compressor thereby establishing a fluid flow in the inlet passage; and

measuring characteristics of the fluid flow in the inlet passage proximate to the inlet passage wall and proximate to the impeller.

2. A method as in Claim 1 wherein the step of measuring the fluid flow includes detecting a reversal in the fluid flow direction.

3. A method as in Claim 1 wherein the step of measuring the fluid flow includes measuring a tangential component to the fluid flow.

4. A method as in Claim 1 wherein the step of measuring the fluid flow includes measuring a substantial decrease in the axial fluid flow.

5. A method as in Claim 1 wherein the step of measuring the fluid flow includes measuring changes in the fluid flow temperature.

6. A method as in Claim 2 wherein the step of measuring the fluid flow includes measuring the fluid flow temperature.

7. A method as in Claim 1 further comprising the step of controlling the flow through the compressor.

8. A method as in Claim 7 wherein the step of controlling the fluid flow includes increasing the fluid flow to the inlet passage.

9. A method as in Claim 2 further comprising the step of controlling the flow through the compressor.

10. A method as in Claim 3 further comprising the step of controlling the flow through the compressor.

11. A method as in Claim 5 further comprising the step of controlling the flow through the compressor.

12. A method as in Claim 4 further comprising the step of controlling the flow through the compressor.

13. A method as in Claim 1 wherein the step of measuring includes measuring the fluid flow using at least one fluid velocity sensor.

14. A method as in Claim 13 wherein the at least one fluid velocity sensor is attached to the inlet passage wall.

15. A method of detecting surge or incipient surge in a centrifugal compressor, the compressor having an impeller and an inlet passage upstream of the impeller, the method comprising the steps of:

operating the compressor, thereby establishing fluid flow through the inlet passage and impeller; and

measuring the fluid flow in a recirculation zone in the inlet passage.

16. A method as in Claim 15 wherein the step of measuring the fluid flow includes detecting a reversal in the fluid flow direction.

17. A method as in Claim 15 wherein the step of measuring the fluid flow includes measuring a tangential component to the fluid flow.

18. A method as in Claim 15 wherein the step of measuring the fluid flow includes measuring a substantial decrease in the axial fluid flow.

19. A method as in Claim 15 wherein the step of measuring the fluid flow includes measuring changes in the fluid flow temperature.

20. A method as in Claim 16 wherein the step of measuring the fluid flow includes measuring changes in the fluid flow temperature.

21. A method as in Claim 15 further comprising the step of controlling the flow through the compressor.

22. A method as in Claim 21 wherein the step of controlling the fluid flow includes increasing the fluid flow to the inlet passage.

23. A method as in Claim 16 further comprising the step of controlling the flow through the compressor.

24. A method as in Claim 20 further comprising the step of controlling the flow through the compressor.

25. A method as in Claim 21 further comprising the step of controlling the flow through the compressor.

26. A method as in Claim 15 wherein the step of measuring includes measuring the fluid flow using at least one fluid velocity sensor.

27. A method as in Claim 26, the inlet passage having an inlet passage wall and wherein the at least one fluid velocity sensor is attached to the inlet passage wall.

28. A method for detecting the occurrence of surge or incipient surge in a fluid flow system, the fluid flow system having a centrifugal compressor in fluid communication with an upstream fluid conduit and a downstream fluid conduit, the centrifugal compressor having an inlet passage and an impeller, the method comprising the steps of:

operating the compressor, thereby establishing fluid flow through the inlet passage and impeller; and

measuring the fluid flow in a recirculation zone in the inlet passage.

29. A method as in Claim 28 wherein the step of measuring the fluid flow includes measuring a reverse in the fluid flow direction.

30. A method as in 28 wherein the step of measuring the fluid flow includes measuring a tangential component to the fluid flow.

31. A method as in Claim 28 wherein the step of measuring the fluid flow includes measuring a substantial decrease in the axial fluid flow.

32. A method as in Claim 28 wherein the step of measuring the fluid flow includes measuring changes in the fluid flow temperature.

33. A method as in Claim 28 further comprising the step of controlling the flow through the compressor.

34. A method as in Claim 33 wherein the step of controlling the fluid flow includes increasing the fluid flow to the inlet passage.

35. A method as in Claim 29 further comprising the step of controlling the flow through the compressor.

36. A method as in Claim 30 further comprising the step of controlling the flow through the compressor.

37. A method as in Claim 31 further comprising the step of controlling the flow through the compressor.

38. A method as in Claim 32 further comprising the step of controlling the flow through the compressor.

39. A method as in Claim 28 wherein the step of measuring includes measuring the fluid flow using at least one fluid velocity sensor.

40. A method as in Claim 39, the inlet passage having an inlet passage wall and wherein the at least one fluid velocity sensor is attached to the inlet passage wall.

41. A method as in Claim 28 wherein the fluid flow system comprises a gas pipeline.

42. A method as in Claim 29 wherein the step of measuring includes measuring changes in the fluid temperature.

43. An apparatus for detecting the occurrence of surge or incipient surge in a centrifugal compressor, the apparatus comprising:
a centrifugal compressor having an inlet passage, an inlet passage wall and an impeller; and
at least one sensor for measuring fluid flow proximate to the impeller and proximate to the inlet passage wall.

44. An apparatus as in Claim 43 wherein at least one sensor is a fluid velocity sensor.

45. An apparatus as in Claim 43 wherein at least one sensor is capable of measuring a reversal in fluid flow direction.

46. An apparatus as in Claim 43 wherein the sensor is capable of measuring a tangential component of fluid flow.

47. An apparatus as in Claim 43 wherein at least one sensor is a temperature sensor.

48. An apparatus as in Claim 44 wherein at least one sensor is a temperature sensor.

49. An apparatus as in Claim 43 wherein the at least one sensor is attached to the inlet passage wall.

50. An apparatus as in Claim 43 further comprising a means of controlling the fluid flow through the centrifugal compressor.

51. An apparatus as in Claim 44 further comprising a means of controlling the fluid flow through the centrifugal compressor.

52. An apparatus as in Claim 45 further comprising a means of controlling the fluid flow through the centrifugal compressor.

53. An apparatus as in Claim 46 further comprising a means of controlling the fluid flow through the centrifugal compressor.